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(54) LH-RH peptide analogues, their uses and pharmaceutical compositions containing them

(57) The invention relates to LH-RH peptide analogues with excellent affinity for LH-RH receptors, of the formula :

A1-A2-A3-A4-A5-A6-Npg-A7-Pro-Z (I)

The invention also relates to the uses of said peptide analogues and to the pharmaceutical compositions containing them.

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Description

This invention relates to LH-RH peptide analogues, to their use and to pharmaceutical compositions in which they are present.

LH-RH, or luteinizing hormone-releasing hormone, is a neurohumoral hormone produced in the hypothalamus which stimulates the secretion of the gonadotrophins, LH (luteinizing hormone) and FSH (follicle-stimulating hormone), which in turn regulate the endocrine and exocrine functions of the ovary in the female, and of the testis in the male. It has the following structural formula :

1 2 3 4 5 6 7 8 9 10

pGlu-His-Trp-Ser-Tyr-Gly-Leu-Arg-Pro-Gly-NH_2

Historically (Karten and Rivier, Endocr. Rev., 1986, 7(1), 44-66), synthetic improvement of LH-RH activity has been achieved first, by replacement of the C-terminal glycinamide by a ethylamide directly bound to Pro^9, and then, by introduction of D-Ala in position 6. Both independent breakthroughs yielded analogs each about 5 times more active than LH-RH. All therapeutically useful agonists result from further major improvement in position 6 with the introduction of hydrophobic aliphatic or aromatic D-amino acids instead of D-Ala, with or without the combined Pro^9-N-ethylamide modification. On this C-terminal end, only slight improvements have been obtained with fluorinated amides or with azaglycinamide. Replacement of Trp in position 3 by 1Nal has been reported (Karten and Rivier, 1986, cf above) to give an agonist twice as potent as LH-RH, without further synthetic or therapeutic developments.

The only other individual amino acid modification noticed to increase the biological activity of some agonists was found in position 7. Thus, N-methylation of Leu^7 in LH-RH itself did not increase its potency, but enhanced the activity of some already potent synthetic agonists with certain D-amino acids in position 6 such as D-Trp (Karten and Rivier, 1986, cf above) ; furthermore, charged and bulkier L-amino acids than leucine (Ser(OBu^t), Asp(O-Bu^t), Glu(O-Bu^t), BocLys) somewhat improved the activity of [des-Gly^{10}; Pro^9-N-ethylamide]-LH-RH but reduced the potency of 6-modified agonists (Karten and Rivier, 1986, cf above).

As far as antagonists are concerned, numerous modifications in all positions but Pro^9, and a wide variety of combinations among them, have been tried with unequal success to achieve inhibition of endogenous LH-RH activity (Dutta, Drugs of the Future, 1988, 13(8), 761-787 ; Karten and Rivier, Endoc. Rev., 1986, 7(1), 44-66). For example, antide, a standard potent LH-RH antagonist, results from amino acid changes in positions 1, 2, 3, 5, 6, 8 and 10. N-methylation of Leu^7 brought about a decrease in potency, and the only changes in this position reported to increase it (2-fold maximum) were the replacement of Leu^7 by Trp^7 or Phe^7.

It has now been found that the replacement of Leu^7 by neopentylglycine (Npg) increases the activity of LH-RH itself and makes it possible to obtain analogs with a high affinity for the LH-RH receptor. More specifically, the [Npg^7]-LH-RH analogues of this invention are potent LH-RH agonists / antagonists *in vivo*.

Thus, according to one aspect of the present invention, LH-RH peptide analogues with high affinity for the LH-RH receptors are provided, in which Npg^7 is substituted for Leu^7. Preferably these peptides are of the formula (SEQ ID N° : 1):

A1-A2-A3-A4-A5-A6-Npg-A7-Pro-Z (I)

in which:

- A1 is pGlu ; D-pGlu ; Sar ; AcSar ; Pro or a derivative thereof such as AcPro, ForPro, OH-Pro, Ac-OH-Pro, dehydro-Pro or Ac-dehydro-Pro ; Ser ; D-Ser ; Ac-D-Ser ; Thr ; D-Thr ; Ac-D-Thr ; or a aromatic D-amino acid which may be acylated, such as D-Phe, D-Tyr, D-Trp, D-Nal, D-1Nal, D-diphenyl-Ala, D-Bal, D-Pal or D-Qal, where D-Phe and D-Trp may be substituted by one or more halogens, (C_1-C_4)alkyl, (C_1-C_4)alkoxy, nitro or trifluoromethyl groups;
- A2 is a direct bond ; His ; or a aromatic D-amino acid such as D-Phe, D-Tyr, D-Trp, D-Nal, D-1Nal, D-diphenyl-Ala, D-Bal, D-Pal or D-Qal, where D-Phe and D-Trp may be substituted by one or more halogens, (C_1-C_4)alkyl, (C_1-C_4)alkoxy, nitro or trifluoromethyl groups;
- A3 is a aromatic L- or D-amino acid such as Phe, Tyr, Trp, Nal, 1Nal, diphenyl-Ala, Bal, Pal or Qal, where Phe and Trp may be substituted by one or more halogens, (C_1-C_4)alkyl, (C_1-C_4)alkoxy, nitro or trifluoromethyl groups;
- A4 is Ala, Ser, D-Ser, MeSer, Ser(OBu^t), Ser(OBzl) or Thr;
- A5 is a aromatic L-amino acid such as Phe, Tyr, Trp, Nal, 1Nal, diphenyl-Ala, Bal, Pal or Qal, where Phe and Trp may be substituted by one or more halogens, (C_1-C_4)alkyl, (C_1-C_4)alkoxy, nitro or trifluoromethyl groups ; or a basic L- or D-amino acid such as Arg, HArg, Orn, Lys, HLys, Cit, HCit, APhe or ACha, where Arg and HArg may be N-substituted by a (C_1-C_6)alkyl or a (C_3-C_6)cycloalkyl group on one or both nitrogen atoms, and where Orn, Lys, HLys, APhe and ACha may be N-substituted by one or two (C_1-C_6)alkyl or (C_3-C_6)cycloalkyl groups, or by a nico-

tinoyl, isonicotinoyl, 6-methyl-nicotinoyl, glycyl-nicotinoyl, nicotinyl-azaglycyl, furyl, glycyl-furyl, furyl-azaglycyl, pyrazinyl, pyrazinyl-carbonyl, picolinoyl, 6-methyl-picolinoyl, shikimyl, shikimyl-glycyl, Fmoc or Boc group;

- A6 is Gly ; D-Pro ; D-Ser ; D-Thr ; D-Cys ; D-Met ; D-Pen ; D-(S-Me)Pen ; D-(S-Et)Pen ; D-Ser(OBu^t) ; D-Asp(OBu^t) ; D-Glu(OBu^t) ; D-Thr(OBu^t) ; D-Cys(OBu^t) ; D-Ser(OR_1) where R_1 is a sugar moiety ; an aza-amino acid such as azaGly or azaAla ; D-His which may be substituted on the imidazole ring by a (C_1-C_6)alkyl or by a (C_2-C_7)acyl group ; an aliphatic D-amino acid with a (C_1-C_8)alkyl or a (C_3-C_6)cycloalkyl side chain such as D-Ala, D-Abu, D-Aib, D-3Aib, D-Val, D-Nva, D-Leu, D-Ile, D-Tle, D-Nle, D-Hol, D-Npg, D-CPa, D-Cpa, D-Cba or D-Cha ; an aromatic D-amino acid such as D-Phe, D-Tyr, D-Trp, D-Nal, D-1Nal, D-diphenyl-Ala, D-anthryl-Ala, D-phenanthryl-Ala, D-benzhydryl-Ala, D-fluorenyl-Ala, D-Bal, D-Pal or D-Qal, where D-Phe and D-Trp may be substituted by one or more halogens, (C_1-C_4)alkyl, (C_1-C_4)alkoxy, nitro or trifluoromethyl groups ; D-cyclohexadienyl-Gly ; D-perhydronaphthyl-Ala ; D-perhydrodiphenyl-Ala ; or a basic L- or D-amino acid such as Arg, HArg, Orn, Lys, HLys, Cit, HCit, APhe or ACha where Arg and HArg may be N-substituted by a (C_1-C_6)alkyl or a (C_3-C_6)cycloalkyl group on one or both nitrogen atoms, and where Orn, Lys, HLys, APhe and ACha may be N-substituted by one or two (C_1-C_6)alkyl or (C_3-C_6)cycloalkyl groups, or by a nicotinoyl, isonicotinoyl, 6-methyl-nicotinoyl, glycyl-nicotinoyl, nicotinyl-azaglycyl, furyl, glycyl-furyl, furyl-azaglycyl, pyrazinyl, pyrazinyl-carbonyl, picolinoyl, 6-methyl-picolinoyl, shikimyl, shikimyl-glycyl, Fmoc or Boc group;
- Npg may be N-alpha-substituted by a (C_1-C_4)alkyl group which may be substituted by one or several fluorine atoms;
- A7 is a basic L-or D-amino acid such as Arg, HArg, Orn, Lys, HLys, Cit, HCit, APhe or ACha, where Arg or HArg may be N-substituted by a (C_1-C_6)alkyl or a (C_3-C_6)cycloalkyl group on one or both nitrogen atoms, ad where Orn, Lys, HLys, APhe or ACha may be N-substituted by one or two (C_1-C_6)alkyl or (C_3-C_6)cycloalkyl groups, or by a nicotinoyl, isonicotinoyl, 6-methyl-nicotinoyl, glycyl-nicotinoyl, nicotinyl-azaglycyl, furyl, glycyl-furyl, furyl-azaglycyl, pyrazinyl, pyrazinyl-carbonyl, picolinoyl, 6-methyl-picolinoyl, shikimyl, shikimyl-glycyl, Fmoc or Boc group;
- Z is $GlyNH_2$; D-$AlaNH_2$; $azaGlyNH_2$; or a group -NHR_2 where R_2 is a (C_1-C_4)alkyl which may be substituted by an hydroxy or one or several fluorine atoms, a (C_3-C_6)cycloalkyl, or a heterocyclic radical selected from morpholinyl, pyrrolidinyl and piperidyl;

as well as their pharmaceutically acceptable salts.

In the present description the term "(C_1-C_4)alkyl" denotes methyl, ethyl, n-propyl, i-propyl, n-butyl, i-butyl, s-butyl and t-butyl groups.

The term "(C_1-C_6)alkyl" denotes methyl, ethyl, n-propyl, i-propyl, n-butyl, i-butyl, s-butyl, t-butyl, n-pentyl, i-pentyl, s-pentyl, t-pentyl and hexyl groups.

The term "(C_1-C_8)alkyl" denotes methyl, ethyl, n-propyl, i-propyl, n-butyl, i-butyl, s-butyl, t-butyl, n-pentyl, i-pentyl, s-pentyl, t-pentyl, hexyl, heptyl and octyl groups ;

The term "(C_1-C_4)alkoxy" denotes a group -OR where R is a (C_1-C_4)alkyl.

The term "(C_2-C_7)acyl" denotes a group -COR where R is a (C_1-C_6)alkyl.

The term "(C_3-C_6)cycloalkyl" denotes cyclopropyl, cyclobutyl, cyclopentyl and cyclohexyl groups.

The term "sugar moiety" denotes D- or L-pentoses or hexoses and their amino-derivatives.

The term "LH-RH analogues" denotes peptides in which at least one amino acid has been modified in the sequence of LH-RH.

In the present description and in the claims, the following abbreviations are used :

Abu : 2-aminobutyric acid
Ac : acetyl
ACha : aminocyclohexylalanine
Aib : 2-aminoisobutyric acid
3Aib : 3-aminoisobutyric acid
Ala : alanine
$AlaNH_2$: alaninamide
APhe : p-aminophenylalanine
Arg : arginine
Asp : aspartic acid
azaAla : aza-alanine
azaGly : aza-glycine
$azaGlyNH_2$: azaglycinamide
Bal : benzothienylalanine
Boc : *tert*-butoxycarbonyl
Cba : cyclobutylalanine

Cha : cyclohexylalanine
Cit : citrulline
CPa : cyclopropylalaine
Cpa : cylopentylalanine
Fmoc : fluorenylmethoxycarbonyl
For : formyl
Glu : glutamic acid
Gly: glycine
$GlyNH_2$: glycinamide
HArg : homoarginine
HCit : homocitrulline
His : histidine
HLys : homolysine
Hol : homoleucine
Ile : isoleucine
IprLys : N^{ε}-isopropyllysine
Leu : leucine
Lys : lysine
MeSer : N-methylserine
Met : methionine
Nal : 3-(2-naphtyl)alanine
1Nal : 3-(1-naphtyl)alanine
NEt : N-ethylamide
NicLys : N^{ε}-nicotinoyllysine
Nle : norleucine
Npg : neopentylglycine
Nva : norvaline
OBu^t : *tert*-butoxy
OBzl : benzyl ester
Orn : ornithine
Pal : 3-(3-pyridyl)alanine
pClPhe : 3-(4-chlorophenyl)alanine
Pen : penicillamine
pGlu : pyroglutamic acid
Phe : phenylalanine
Pro : proline
Qal : 3-(3-quinolyl)alanine
Sar : sarcosine
Ser : serine
(S-Me)Pen : S-methyl-penicillamine
(S-Et)Pen : S-ethyl-penicillamine
Thr : threonine
Tle : tert-leucine
Trp : tryptophan
Tyr : tyrosine
Val : valine

A preferred group of peptides according to the invention, having LH-RH agonist activity, comprises the peptides of the formula (SEQ ID N° : 2):

A1-A2-A3-A4-A5-A6-Npg-A7-Pro-Z (IIa)

in which:

- A1 is pGlu, Sar or AcSar;
- A2 is His;
- A3 is an aromatic L-amino acid such as Phe, Tyr, Trp, Nal, 1Nal, diphenyl-Ala, Bal, Pal or Qal, where Phe and Trp may be substituted by one or more halogens, $(C_1$-$C_4)$alkyl, $(C_1$-$C_4)$alkoxy, nitro or trifluoromethyl groups;
- A4 is Ala, Ser, D-Ser, MeSer, $Ser(OBu^t)$, Ser(OBzl) or Thr;
- A5 is an aromatic L-amino acid such as Phe, Tyr, Trp, Nal, 1Nal, diphenyl-Ala, Bal, Pal or Qal, where Phe and Trp

may be substituted by one or more halogens, (C_1-C_4)alkyl, (C_1-C_4)alkoxy, nitro or trifluoromethyl groups;

- A6 is Gly ; D-Pro ; D-Ser ; D-Thr ; D-Cys ; D-Met ; D-Pen ; D-(S-Me)Pen ; D-(S-Et)Pen ; D-Ser(OBu^t) ; D-Asp(OBu^t) ; D-Glu(OBu^t) ; D-Thr(OBu^t) ; D-Cys(OBu^t) ; D-Ser(OR_1) where R_1 is a sugar moiety ; an aza-amino acid such as azaGly or azaAla ; D-His which may be substituted on the imidazole ring by a (C_1-C_6)alkyl or by a (C_2-C_7)acyl group ; an aliphatic D-amino acid with a (C_1-C_8)alkyl or a (C_3-C_6)cycloalkyl side chain such as D-Ala, D-Abu, D-Aib, D-3Aib, D-Val, D-Nva, D-Leu, D-Ile, D-Tle, D-Nle, D-Hol, D-Npg, D-CPa, D-Cpa, D-Cba or D-Cha ; an aromatic D-amino acid such as D-Phe, D-Tyr, D-Trp, D-Nal, D-1Nal, D-diphenyl-Ala, D-anthryl-Ala, D-phenanthryl-Ala, D-benzhydryl-Ala, D-fluorenyl-Ala, D-Bal, D-Pal or D-Qal, where D-Phe and D-Trp may be substituted by one or more halogens, (C_1-C_4)alkyl, (C_1-C_4)alkoxy, nitro or trifluoromethyl groups ; D-cyclohexadienyl-Gly ; D-perhydronaphthyl-Ala ; D-perhydrodiphenyl-Ala ; or a basic D-amino acid such as D-Arg, D-HArg, D-Orn, D-Lys, D-HLys, D-Cit, D-HCit, D-APhe or D-ACha, where D-Arg and D-HArg may be N-substituted by a (C_1-C_6)alkyl or a (C_3-C_6)cycloalkyl group on one or both nitrogen atoms, and where D-Orn, D-Lys, D-HLys, D-APhe and D-ACha may be N-substituted by one or two (C_1-C_6)alkyl or (C_3-C_6)cycloalkyl groups, or by a Fmoc or Boc group;
- Npg may be N-alpha-substituted by a (C_1-C_4)alkyl group which may be substituted by one or several fluorine atoms;
- A7 is a basic L-amino acid such as Arg, HArg, Orn, Lys, HLys, Cit, HCit, APhe or ACha;
- Z is $GlyNH_2$; azaGlyNH_2 ; or a group $-NHR_2$ where R_2 is a (C_1-C_4)alkyl which may be substituted by a hydroxy or one or several fluorine atoms, a (C_3-C_6)cycloalkyl or a heterocyclic radical selected from morpholinyl, pyrrolidinyl and piperidyl; as well as their pharmaceutically acceptable salts.

Another preferred group of peptides according to the invention, having LH-RH antagonistic activity, comprises the peptides of the formula (SEQ ID N° : 3):

A1-A2-A3-A4-A5-A6-Npg-A7-Pro-Z (IIb)

in which:

- A1 is pGlu ; D-pGlu ; Sar ; AcSar ; Pro or a derivative thereof such as AcPro, ForPro, OH-Pro, Ac-OH-Pro, dehydro-Pro or Ac-dehydro-Pro ; Ser ; D-Ser ; Ac-D-Ser ; Thr ; D-Thr ; Ac-D-Thr ; or an aromatic D-amino acid which may be acylated such as D-Phe, D-Tyr, D-Trp, D-Nal, D-1Nal, D-diphenyl-Ala, D-Bal, D-Pal or D-Qal, where D-Phe and D-Trp may be substituted by one or more halogens, (C_1-C_4)alkyl, (C_1-C_4)alkoxy, nitro or trifluoromethyl groups;
- A2 is a direct bond or an aromatic D-amino acid such as D-Phe, D-Tyr, D-Trp, D-Nal, D-1Nal, D-diphenyl-Ala, D-Bal, D-Pal or D-Qal, where D-Phe and D-Trp may be substituted by one or more halogens, (C_1-C_4)alkyl, (C_1-C_4)alkoxy, nitro or trifluoromethyl groups;
- A3 is an aromatic L- or D-amino acid such as Phe, Tyr, Trp, Nal, 1Nal, diphenyl-Ala, Bal, Pal or Qal, where Phe and Trp may be substituted by one or more halogens, (C_1-C_4)alkyl, (C_1-C_4)alkoxy, nitro or trifluoromethyl groups;
- A4 is Ala, Ser, D-Ser, MeSer, Ser(OBu^t), Ser(OBzl) or Thr;
- A5 is an aromatic L-amino acid such as Phe, Tyr, Trp, Nal, 1Nal, diphenyl-Ala, Bal, Pal or Qal, where Phe and Trp may be substituted by one or more halogens, (C_1-C_4)alkyl, (C_1-C_4)alkoxy, nitro or trifluoromethyl groups ; or a basic L-or D-amino acid such as Arg, HArg, Orn, Lys, HLys, Cit, HCit, APhe or ACha, where Arg and HArg may be N-substituted by a (C_1-C_6)alkyl or (C_3-C_6)cycloalkyl group on one or both nitrogen atoms, and where Orn, Lys, HLys, APhe and ACha may be N-substituted by one or two (C_1-C_6)alkyl or (C_3-C_6)cycloalkyl groups, or by a nicotinoyl, isonicotinoyl, 6-methyl-nicotinoyl, glycyl-nicotinoyl, nicotinyl-azaglycyl, furyl, glycyl-furyl, furyl-azaglycyl, pyrazinyl, pyrazinyl-carbonyl, picolinoyl, 6-methyl-picolinoyl, shikimyl, shikimyl-glycyl, Fmoc or Boc group;
- A6 is Gly ; D-Pro ; D-Ser ; D-Thr ; D-Cys ; D-Met ; D-Pen ; D-(S-Me)Pen ; D-(S-Et)Pen ; D-Ser(OBu^t) ; D-Asp(OBu^t) ; D-Glu(O-Bu^t) ; D-Thr(O-Bu^t) ; D-Cys(O-Bu^t) ; D-Ser(O-R_1) where R_1 is a sugar moiety ; an aliphatic D-amino acid with a (C_1-C_8)alkyl or a (C_3-C_6)cycloalkyl side chain such as D-Ala, D-Abu, D-Aib, D-3Aib, D-Val, D-Nva, D-Leu, D-Ile, D-Tle, D-Nle, D-Hol, D-Npg, D-CPa, D-Cpa, D-Cba or D-Cha ; an aromatic D-amino acid such as D-Phe, D-Tyr, D-Trp, D-Nal, D-1Nal, D-diphenyl-Ala, D-anthryl-Ala, D-phenanthryl-Ala, D-benzhydryl-Ala, D-fluorenyl-Ala, D-Bal, D-Pal or D-Qal, where D-Phe and D-Trp may be substituted by one or more halogens, (C_1-C_4)alkyl, (C_1-C_4)alkoxy, nitro or trifluoromethyl groups ; D-cyclohexadienyl-Gly ; D-perhydronaphthyl-Ala ; D-perhydrodiphenyl-Ala ; or a basic L-or D-amino acid such as Arg, HArg, Orn, Lys, HLys, Cit, HCit, APhe or ACha, where Arg and HArg may be N-substituted by a (C_1-C_6)alkyl or (C_3-C_6)cycloalkyl group on one or both nitrogen atoms, and where Orn, Lys, HLys, APhe and ACha may be N-substituted by one or two (C_1-C_6)alkyl or (C_3-C_6)cycloalkyl groups, or by a nicotinoyl, isonicotinoyl, 6-methyl-nicotinoyl, glycyl-nicotinoyl, nicotinyl-azaglycyl, furyl, glycyl-furyl, furyl-azaglycyl, pyrazinyl, pyrazinyl-carbonyl, picolinoyl, 6-methyl-picolinoyl, shikimyl, shikimyl-glycyl, Fmoc or Boc group;
- Npg may be N-alpha-substituted by a (C_1-C_4)alkyl group which may be substituted by one or several fluorine atoms;
- A7 is a basic L- or D-amino acid such as Arg, HArg, Orn, Lys, HLys, Cit, HCit, APhe or ACha, where Arg and HArg may be N-substituted by a (C_1-C_6)alkyl or (C_3-C_6)cycloalkyl group on one or both nitrogen atoms, and where Orn,

Lys, HLys, APhe and ACha may be N-substituted by one or two (C_1-C_6)alkyl or (C_3-C_6)cycloalkyl groups, or by a nicotinoyl, isonicotinoyl, 6-methyl-nicotinoyl, glycyl-nicotinoyl, nicotinyl-azaglycyl, furyl, glycyl-furyl, furyl-azaglycyl, pyrazinyl, pyrazinyl-carbonyl, picolinoyl, 6-methyl-picolinoyl, shikimyl, shikimyl-glycyl, Fmoc or Boc group;

- Z is $GlyNH_2$ or D-$AlaNH_2$; as well as their pharmaceutically acceptable salts.

Among the peptides of formula (IIa), those of the formula (SEQ ID N° : 4):

pGlu-His-Trp-Ser-Tyr-A6-Npg-Arg-Pro-Z (IIIa)

in which :

- A6 is Gly ; an aliphatic D-amino acid with a (C_1-C_8)alkyl side chain ; or an aromatic D-amino acid ;
- Npg is optionally N-alpha-methylated ;
- Z is $GlyNH_2$ or a group - NHC_2H_5 ;

and their pharmaceutically acceptable salts,
are especially preferred.

Among the peptides of formula (IIb), those of the formula (SEQ ID N° : 5):

Ac-D-Nal-D-pClPhe-D-Pal-Ser-A5-A6-Npg-A7-Pro-D-$AlaNH_2$ (IIIb)

in which :

- A5 and A7 are as defined above for (IIb) ;
- A6 is Gly or a basic L- or D-amino acid ;
- Npg is optionally N-alpha-methylated

and their pharmaceutically acceptable salts,
are especially preferred.

Examples of the salts with pharmaceutically acceptable acids are those with mineral acids, such as for example the hydrochloride, hydrobromide, sulfate, phosphate, borate, hydrogensulfate, dihydrogenphosphate or nitrate, and those with organic acids, such as for example the acetate, oxalate, tartrate, succinate, maleate, fumarate, gluconate, citrate, pamoate, malate, ascorbate, benzoate, p-toluenesulfonate or naphtalenesulfonate.

Examples of the salts with pharmaceutically acceptable bases are those with alkali or alkaline earth metals such as sodium, potassium, calcium or magnesium, and those with organic bases such as amines, trometamol, N-methyl-glutamine, and the like.

The peptides according to the present invention can be prepared by the well-known techniques of peptide chemistry such as for example peptide synthesis in solution or solid phase peptide synthesis. In general, these techniques involve the stepwise addition of one or more amino acids -which may be suitably protected- to a forming peptide chain.

Preferably, the peptides according to the invention are synthesized using stepwise solid phase synthesis (1,2) with N-α-Fmoc protection. For example, the peptides are assembled on a 4-methylbenzylhydrylamine resin (Peninsula Laboratories, UK) or on an aminomethyl resin (Peninsula Laboratories, UK). The C-terminal proline is introduced as 4-(Boc-Prolyloxymethyl)phenyl acetic acid. Subsequent removal of the Boc protecting group is achieved with trifluoroacetic acid followed by dichloromethane and dimethylformamide (DMF) washing as well as diisopropylethylamine neutralization. It is also possible to use a "Rink" resin (4-(2',4'-dimethoxyphenyl)-Fmoc-aminomethylphenoxy resin) using Fmoc strategy of synthesis (2).

The synthesis comprises assembling, cleavage and purification steps, as described below :

I. Assembling

For all the peptides the following deprotection/coupling procedure is used :

1 -	DMF washing	(3 times - 1 min.)
2 -	Piperidine 25 % in DMF	(1 min.)
3 -	Piperidine 25 % in DMF	(twice - 15 min.)
4 -	DMF washing	(7 times - 1 min.)

For each step 15 ml of solvent per gram of peptide resin are used.

Coupling of all amino acid (three fold excess) is performed in DMF in the presence of BOP, Hobt and DIEA (3). Each coupling step is controlled for completion by the ninhydrine test (4) and double coupling is performed if necessary. If, after the second coupling the test still remains positive, the resin is acetylated (acetic acid anhydride, 10 fold excess and DIEA).

Generally, a trifluoroacetic acid (TFA) treatment is performed prior to the deprotection/cleavage step.

II. Cleavage

The peptides are cleaved from the resin and fully deprotected by a treatment with either liquid hydrogen fluoride (HF) or TFA. 10 ml of HF or TFA per gram of peptide resin are used classically at 0° C for 45 min. or 2.5 hours, respectively, in the presence of p-cresol and ethanedithiol (for tryptophan-containing peptides) as scavengers.

After evaporation of the HF, the crude reaction mixture is washed with diethyl ether, dissolved in TFA, precipitated with diethyl ether and dried under reduced pressure.

If need be, prior to HF deprotection the peptide is cleaved from the resin and subsequently amidated by a treatment with ethylamine (5 ml ethylamine per gram of petpide resin, - 78°C, 20 hours).

When a benzyl group is present in the final product, TFA is used (10 ml per gram of peptide resin, 0° C, 2,5 hours) for the final cleavage/deprotection.

The composition of the TFA cleavage mixture in v % is the following :

TFA	: 83.3%
Ethanedithiol	: 2.1%
Thioanisol	: 4.2%
Water	: 4.2%
Phenol	: 6.2 %

After filtration of the resin, the peptide is precipitated from the reaction mixture by addition of a large amount of diethylether. After several washings with diethylether the crude peptide is dried under reduced pressure.

III. Purification

All the peptides are purified by reverse phase liquid chromatography.

The general procedure of purification is identical for each peptide ; however the gradient of organic solvent is adjusted depending on the initial retention time of the peptide.

General conditions of purification :

Equipment	: KRONWALD SPERATIONSTECHNIK, Medium Pressure liquid chromatography system (Germany) equipped with Glass column.
Stationnary phase	: silica Bondapack C18 (Waters) 15-25 µm, 100 A
Size of column	: 40 x 340 mm
Elution conditions:	
Mobile phase:	Eluant A : 0.1 % TFA in water Eluant B : CH_3CN/A 60/40 (volume)
Temperature	: Room
Flow rate	: 40 ml
Detection	: UV 210 nm
Fractioning	: 5 ml per fraction

All fractions containing the target compound are individually analyzed by analytical HPLC. The fractions with a purity higher than 95 % are pooled and freeze-dried. In case the requested purity is not reached after the first purification step, a second purification step and, if need be, a third purification step are performed. The conditions of purification for the second and third steps are similar as those described above except that the slope of the gradient is modified in order to increase the resolution.

After lyophilisation, all purified peptides are present as their trifluoroacetate salt. The final powder corresponding to each peptide is controlled by analytical HPLC. The structure of each compound is also assessed by mass spectral analysis and the net peptide content is determinated by UV absorption.

The peptides according to the present invention have a potent affinity for the LH-RH receptors.

This affinity has been determined according to the following method:

Pituitaries from female Sprague Dawley rats were removed and homogenized with a Potter homogenizer in a 25 mM HEPES buffer (pH 7.4) containing 0.32 M sucrose, 100 µg/l PMSF (phenylmethylsulfonylfluoride), 5.6 U/l aprotinin and 10 000 U/l bacitracin. The homogenates were centrifuged at 700 g for 10 minutes and the supernatants were further centrifuged at 12,500 g for 30 minutes. The pellets were homogenized and centrifuged as described above, but in

the same buffer without sucrose.

All homogenization, centrifugation and subsequent incubation steps were carried out at 4° C.

Aliquots of membrane fractions were incubated for 2 hours in duplicate with increasing concentrations of test compounds in the presence of 20 to 70 pM of [^{125}I]-buserelin (between 1000 and 2000 Ci/mmol depending on ligand batches). The assay was terminated by filtration under suction (Brandel 96-well harvester) through Whatman GF/B glass fiber filters. After repeated washes, filters were placed in counting vials with scintillation cocktail to measure the radioactivity of ^{125}I. For each experiment, curve-fitting of residual specific binding against concentrations of test compound gave the 50% inhibitory concentration (IC_{50}). Each compound was tested in at least 4 experiments.

This LH-RH receptor assay was characterized by 4 saturation experiments using increasing concentration of [^{125}I]-buserelin in the absence or presence of 1 µM unlabelled buserelin for non specific binding determination. Specific binding data were analysed according to Scatchard's method. At equilibrium (2 hours of incubation), the dissociation constant (Kd) and the number of binding sites for [^{125}I]-buserelin were respectively equal to 88 ± 6 pM and 15.6 ± 2.9 pM.

For each test compound, the inhibitory constant (Ki) was calculated from its IC_{50} according to the Cheng and Prussof's equation : $Ki = IC_{50}/(1 + [radioligand]/Kd)$. Ki were then transformed into pKi (=- log Ki) for final expression of affinity scales.

The natural ligand, LH-RH itself, displays a strong affinity with experimental IC_{50} in the 10 nM range, i.e., a pKi equal to about 8.

So-called superagonists like buserelin, leuprorelin, tryptorelin, histrelin or deslorelin and antagonists like antide show an even stronger binding to LH-RH receptors with IC_{50} in the subnanomolar range, i.e. pKi > 9.

The affinity of test peptides of the invention for the LH-RH receptors is given in Table 1 below :

Table 1

Affinity for LH-RH receptors			
Compound	pKi (n)	Compound	pKi (n)
Example 1	8.83 (3)	Example 14	9.50 (3)
Example 2	9.61 (3)	Example 15	9.23 (3)
Example 3	9.57 (3)	Example 16	10.17 (3)
Example 4	10.01 (3)	Example 17	9.72 (3)
Example 5	8.86 (3)	Example 18	10.07 (3)
Example 6	9.33 (3)	Example 19	10.11 (3)
Example 7	8.20 (3)	LH-RH	8.04 (4)
Example 8	8.73 (3)	Goserelin	8.58 (4)
Example 9	8.63 (3)	Antide	9.16 (12)
Example 10	9.64 (3)	Leuprorelin	9.33 (4)
Example 11	9.34 (3)	Buserelin	9.35 (108)
Example 12	9.79 (4)	Tryptorelin	9.85 (4)
Example 13	8.97 (3)	Deslorelin	9.90 (4)
		Histrelin	9.98 (4)

(n) : number of determinations

The peptides according to the general formula (IIa) exert an agonist activity upon the LH-RH receptors *in vivo*, resulting in the stimulation of LH secretion by the pituitary, which, in males, stimulates the secretion of testosterone by the testis.

Adult male Sprague-Dawley rats received a subcutaneous injection of various doses of LH-RH, tryptorelin or leuprorelin, or their respective counterpart with Npg^7 replacing Leu^7 : example 1 ([Npg^7]-LH-RH), example 6 ([Npg^7]-leuprorelin) or example 11 ([Npg^7]-tryptorelin), dissolved in phosphate-buffered saline (PBS). Two hours later, blood samples were drawn for total plasma testosterone determination by direct radioimmunoassay (Immunotech). Example I was a little more than twice as active as LH-RH itself, and the other compounds behaved like so-called ((superagonists)) by inducing a stronger stimulation of testosterone secretion at much lower doses (logarithmic x axis)

than LH-RH (Figure 1; 8 animals per point). At 20 ng/kg, the secretion of testosterone was equally maximally stimulated by the four superagonists (exponential y axis scale), but at 10 ng/kg, examples 6 and 11 were a little more than twice as active as leuprorelin and tryptorelin, respectively.

At the same dose of 10 ng/kg, examples 4, 12, 3 and 10 were respectively 1.2, 1.7, 2.6 and 5 times more active than their [Leu^7]-parent-compound. Thus, when available from Bachem or Sigma, the known LH-RH agonists were all less potent than their corresponding example according to the present invention relating to the advantage of Npg^7 over Leu^7. The level of stimulation obtained by examples 5 and 13, although not in direct comparison with their Leu^7 counterpart, was also very high, similar to that of leuprorelin and tryptorelin, and example 9 displayed an even higher potency, similar to that of examples 6 and 11. The above results are shown in Table 2 below or in Figure 1.

Table 2

Stimulation of testosterone secretion			
Compound	Dose (ng/kg)	Total plasma testosterone (nmol/l)	n
Vehicle (PBS)	--	0.8 ± 0.2	20
[D-Ala^6]-LH-RH	10	6.4 ±1.9 *	8
Example 3	10	16.7 ±1.9 ***	8
[D-Ala^6, Pro^{9}NEt]-LH-RH	10	11.1 ±3.3 **	8
Example 4	10	12.9 ±1.3 ***	8
[D-Phe^6, Pro^{9}NEt]-LH-RH	10	2.8 ±0.5 *	8
Example 10	10	14.1 ±3.0 ***	8
Deslorelin	10	11.8 ±3.5 **	6
Example 12	10	20.5 ±5.2 ***	6
Example 5	10	21.2 ±6.6 ***	6
Example 9	10	30.9 ±3.6 ***	8
Example 13	10	22.9 ±4.2 ***	6
n : number of animals			

* $p < 0.05$;
** $p < 0.01$;
*** $p < 0.001$ compared to vehicle alone

The peptides according to the general formula (IIb) exert an antagonistic activity upon the LH-RH receptors *in vivo*, resulting in the inhibition of ovulation in the female.

Adult female Wistar rats are first monitored for normal estrous cyclicity by daily vaginal smears. After at least 2 regular 4-day cycles, they received by subcutaneous injection either the vehicle alone (0.5 ml of a mixture of propyleneglycol and water : 20/80 vol/vol), or the LH-RH antagonist according to the formula (IIb) dissolved in this vehicle, around 2:00 PM on the day of proestrus. All but one vehicle-treated animals ovulated spontaneously as demonstrated by the recovery of numerous ovocytes in the oviducts the following morning.

If effective, LH-RH antagonists totally block ovulation. Antide, a commercially available standard LH-RH antagonist (from Bachem), was sub-maximally active at the dose of 1 µg/rat but lost most of its potency at the dose of 0-5 mg/rat. Replacement of Leu^7 by Npg^7 in antide resulted in an increased activity at the even lower dose of 0.25 µg/rat (Example 15). Examples 16, 18 and 19 appeared slightly more active than antide and example 17 was the most potent compound, showing that Npg^7 is compatible with various combinations of basic amino acids in positions 6 and 8 that are characretistic of most other standard LH-RH antagonists such as cetrorelix or antarelix. With still sub-maximal efficacy to inhibit ovulation at the dose of 0.25 µg/rat, example 17, and to a lesses extent example 15, are especially promising. The above results are shown in Table 3.

Table 3

Inhibition of ovulation		
Treatment	Dose (µg/rat)	Number of ovulating females /total number of treated females
Vehicle	--	27/28
Antide	5	0/5
	1	1/8
	0.5	4/5
[Npg^7]-Antide (Example 15)	1	1/5
	0.25	2/5
Example 16	1	0/5
	0.25	4/5
Example 17	1	0/5
	0.25	1/5
Example 18	1	1/5
	0.25	4/5
Example 19	1	0/5
	0.25	3/5

In conclusion of both agonist and antagonistic studies *in vivo*, it has been shown that replacement of Leu^7 by Npg^7 in LH-RH analogues gives compounds with at least equivalent therapeutic potential or, more frequently, increases the potency of existing analogues. Moreover, other peptides according to the invention that are not direct counterparts of known therapeutic LH-RH analogues, displayed an even greater potency. The use of neopentylglycine in place of leucine in position 7, or in any homologous position, is therefore claimed as a general structural feature useful in the design of any new LH-RH analogue.

No sign of toxicity is observed with the peptides of the invention at pharmaceutically active doses.

Thus, the peptides of the invention and their pharmaceutically acceptable salts may be used in the treatment or prevention of various complaints or diseases wherein a LH-RH agonist or antagonist activity is required.

The main target of LH-RH analogues is the pituitary gland, but direct actions have been reported on the gonads themselves (testis and ovary), on the thymus and some lymphoid cell lines, on mast cells and on breast, prostate or pancreatic tumors.

LH-RH agonists according to formula (IIa) exert on any LH-RH sensitive target, either a stimulatory activity by short-term acute or pulsatile administrations, or an inhibitory effect by repeated or continuous administrations that induce the desensitization and the down-regulation of LH-RH receptors. In the case of the hypothalamo-pituitary-gonadal axis, prolonged administration results in a so-called "chemical" castration.

LH-RH antagonists according to formula (IIb) exert primarily an inhibitory effect on any LH-RH-sensitive target, but are also useful in obtaining or planning a rebound stimulatory release of LH and FSH when treatment is discontinued.

Due to this ambivalent potential of both LH-RH agonists and antagonists, all analogues according to formula (I) can find an appropriate therapeutic use in humans as well as in animals, depending on doses, treatment regimens and routes of administration, in reproductive endocrinology and in the treatment or prevention of sex hormone-dependent benign or malignant tumors, alone or in combination with other hormonal or antitumoral agents. LH-RH sensitive sex hormone-independent benign or malignant tumors can also regress upon treatment with LH-RH analogues according to formula (I), alone or in combination with antitumoral agents. Immune mechanisms can also be modified by LH-RH analogues according to formula (I), alone or in combination with immuno-modulating or -suppresive agents such as glucocorticoids, cyclosporin, rapamycin, tacrolimus, their derivatives, and the like. The LH-RH analogues according to the invention are therefore very valuable in the treatment and prevention of autoimmune diseases, graft rejection or atopic diseases, and in the treatment of benign or malignant lymphoproliferative disorders.

LH-RH analogues according to formula (I) are especially useful, alone or in combination with sex steroids or gonadotrophins, in the inhibition, planning and triggering of ovulation in i*n vitro* fertilization programs, and in the treatment of

male and female infertility or hypogonadic states. Conversely, they can also be used in male or female contraception or treatment of hypergonadic states, alone or in combination with sex steroids or gonadotrophins. This applies to men and women, but also to wild or domestic animals in uses such as improvement or control of reproductive performance, or as a tool to optimize breeding strategies.

LH-RH analogues according to formula (I) are also especially useful in men to treat advanced prostate cancer, but can also be used as a first line therapy in this indication and in benign prostatic hypertrophy, alone or in combination with inhibitors of androgen action, i.e. antiandrogens such as cyproterone acetate, osaterone acetate, chlormadinone acetate, flutamide, nilutamide or bicalutamide and the like, or 5α-reductase inhibitors such as finasteride, epristeride or turosteride and the like, or C_{17-20} lyase inhibitors such as abiraterone and the like.

LH-RH analogues according to formula (I) are also especially useful in the treatment or prevention of breast cancer in women and in men, especially estrogen receptor positive tumors, alone or in combination with antiestrogens such as tamoxifen, raloxifen or droloxifen and the like, or with aromatase inhibitors such as atamestane, formestane, letrozole, anastrozole and the like, or with C_{17-20} lyase inhibitors such as abiraterone and the like, but also of certain estrogen receptor negative tumors that respond to the direct effects of LH-RH analogues or indirectly to their gonadal suppressive activity.

Other gynecological conditions, such as endometrial hyperplasia, leiomyoma, adenomyoma, endometriosis, polycystic ovary syndrome, hirsutism and benign breast disease (pain, cysts or fibrosis), can also be prevented by or benefit from treatment with the LH-RH analogues according to formula (I), alone or in combination with antiestrogens (cited above), progestins such as cyproterone acetate, osaterone acetate, chlormadinone acetate, nomegestrol acetate, promegestone, demegestone, trimegestone and the like, or their contraceptive or post-menopausal replacement combination formulations with estrogens such as estradiol or ethynylestradiol. The peptides of the invention can also interfere with gestation by inducing abortion or by triggering labor, alone or in combination with estrogens (cited above), antiprogestins such as mifepristone or prostaglandin analogs such as sulprostone.

Similar indications can be encountered in veterinary medicine for male or female domestic or wild animals that may require the use of LH-RH analogues according to formula (I).

Another aspect of the present invention is therefore pharmaceutical compositions containing an effective amount of at least one peptide of formula (I) or a pharmaceutically acceptable salt thereof, alone or mixed with suitable pharmaceutical excipients.

A further aspect of the invention relates to a method of treating and/or preventing the above diseases which comprises administering to patients or animals in need thereof a therapeutically effective amount of a peptide of formula (I) or a pharmaceutically acceptable salt thereof.

A further aspect of the invention relates to the use of the peptides of formula (IIa), or of their pharmaceutically acceptable salts, for the preparation of a medicament having LH-RH agonist activity. Also within the scope of the invention is the use of the peptides of formula (IIb), or of their pharmaceutically acceptable salts, for the preparation of a medicament having LH-RH antagonist activity.

The peptides of the invention are preferentially administered by parenteral administration, although oral formulations are also effective provided that the dosage is appropriately increased.

Preferred delivery systems for LH-RH agonists of formula (IIa) in long term pituitary-gonadal suppressive indications are slow-release implantable devices, or injectable biodegradable polymeric micro- or nano-particles or -capsules, or micro- or nano-emulsions, with unit doses of the peptides or of their appropriate salts raging from 1 mg to 100 mg per human patient for a duration of action ranging from 1 month to 1 year. Long term administration of LH-RH antagonists of formula (IIb) will generally require higher dosages in the same slow-release formulations, ranging from 10 mg to 1 g for 1 week to 1 year of activity. Animal doses will be adapted on a body weight basis depending on the wild or domestic species to be treated either by LH-RH agonists or antagonists according to formula (I).

All other means of parenteral administration are suited for immediate, delayed or planned delivery of the peptides of the invention : subcutaneous, intramuscular, intravenous, intragonadal or intratumoral needle bolus injections, or prolonged continuous, pulsatile or planned perfusions or microinfusions using the appropriate pump technology; gas-propelled subcutaneous microinjection ; vaginal creams, gels or pessaries ; rectal enemas or suppositories ; transdermal creams, gels, lotions, solutions, patches or iontophoretic devices ; nasal spray or dry powder inhalation device ; ophtalmic solutions, gels, creams or contact lenses ; pulmonary inhalation of micro- or nano-particles or droplets generated manually or with an appropriate pulverization or nebulization device.

The unit dose of these parenteral administrations will range in humans from 0.001 mg to 10 mg/day for LH-RH agonists of formula (IIa) and from 0.01 to 100 mg/day for LH-RH antagonists of formula (IIb), one to 16 times per day (in the case of pulsatile administration).

Oral administration of peptides according to the invention is preferentially effected using gastro-resistant and delayed enteric or colonic release formulations which can be coated pills or tablets containing two or more components, hardened gelatin capules, special polymeric macro-, micro- or nano-beads containing them, or any device designed to protect them from gastrointestinal degradation and to release them when needed. All other formulations to be taken

orally such as solutions, suspensions, syrups, gels and the like, or lingual, sublingual or chewable formulations are suited provided that the dosage is increased.

Overall, effective oral treatment may be achieved with any of the above formulations with unit doses of peptides of formula (I) ranging from 1 mg to 1 g per human patient, from one to 16 times per day (in the case of pulsatile administration).

All the above-mentioned oral or parenteral formulations of the peptides according to the invention and their pharmaceutical acceptable salts may contain one or several pharmaceutically appropriate excipients, one or several inhibitors of proteases, and one or several absorption enhancers as needed by the specific route of administration.

Raw powder of pure peptides according to the invention or their pharmaceutically acceptable salts can also be used, especially in the lyophilized form for fast sublingual application.

The invention will now be described with reference to the following examples, which are not intended to limit the invention in any respect. In these examples, the starting materials used were either commercially available or synthetized, as mentioned below:

- Fmoc-Glu-OH, Fmoc-Tyr(OBut)-OH, Fmoc-Trp-OH and Fmoc-His(Trt) were purchased from Propeptide (France).
- Fmoc-β-Nal-OH and Fmoc-pClPhe were synthesized as racemates. These amino acids and their corresponding acetyl ethylesters were enzymatically resolved using subtilisin (5) ;
- Other Fmoc protected amino-acids were purchased from Bachem (Switzerland), Novabiochem (Switzerland), American Peptide C° (USA) or Neosystem (France).

EXAMPLE 1 : pGlu-His-Trp-Ser-Tyr-Gly-Npg-Arg-Pro-Gly-NH_2

Example 1 was synthesized on a Rink resin using a Fmoc strategy as mentioned above in the genes synthesis of the invention peptides. Cleavage was carried out with TFA in the presence of scavengers.

Purification was carried out using a linear gradient of from 10 to 40 % of eluent B (CH_3CN/0.1 % TFA 60/40 v/v) over 30 min.

68 mg (approximate yield 24 %) of purified material were obtained.

Mass spectral analysis - ES^+ mode :

expected : 1195.3
found : 1195.7.

net peptide content 73.9% ; purity 97.2% ; retention time 16.4 min.

EXAMPLE 2: pGlu-His-Trp-Ser-Tyr-Gly-Npg-Arg-Pro-NEt

The synthesis was carried out on Boc-Pro-PAM resin. The second amino acid, arginine, was also incorporated via a Boc strategy. The subsequent amino acids were incorporated via a Fmoc strategy. After coupling of the N-terminal amino acid, the peptide was cleaved from the resin and converted into ethylamide by aminolysis using ethylamine (5 ml of ethylamine per gram of peptide resin for 20 hours, -78°C).

After cleavage the protected peptide was extracted with methanol, dried and deprotected with HF as described.

Purification was carried out using a linear gradient of from 10 to 60% of eluent B over 30 min. 15 mg (approximate yield 8%) of purified material were obtained.

Mass spectral analysis - ES^+ mode :

expected : 1166.3
found : 1166.8.

net peptide content 72.7% ; purity 95.0 % ; retention time 15.1 min.

EXAMPLE 3 : pGlu-His-Trp-Ser-Tyr-D-Ala-Npg-Arg-Pro-Gly-NH_2

Assembling and cleavage of the peptide were carried out as described for Example 1.

Purification was carried out using a linear gradient of from 10 to 50 % of eluent B over 30 min.

66 mg (approximate yield 27 %) of purified material were obtained.

Mass spectral analysis - ES^+ mode :

expected : 1209.4
found : 1209.5.

net peptide content 72.6% ; purity 95.2 % ; retention time 14.5 mm.

EXAMPLE 4 : pGlu-His-Trp-Ser-Tyr-D-Ala-Npg-Arg-Pro-NEt

Assembling and cleavage of the peptide were carried out as described for Example 2.
Purification was carried out using a linear gradient of from 10 to 60 % of eluent B over 30 min.
8 mg (approximate yield 7 %) of purified material were obtained.

Mass spectral analysis - ES^+ mode :

expected : 1180.3
found : 1181.0

net peptide content 69.5 % ; purity 96.9 % ; retention time 17.7 min.

EXAMPLE 5 : pGlu-His-Trp-Ser-Tyr-D-Leu-Npg-Arg-Pro-Gly-NH_2

Assembling ad cleavage of the peptide were carried out as described for Example 1.
Purification was carried out using a linear gradient of from 15 to 50 % of eluent B over 30 min.
123 mg (approximate yield 36%) of purified material were obtained.

Mass spectral analysis - ES^+ mode :

expected : 1251.4
found : 1251.9

net peptide content 71.7 % ; purity 95.7 % ; retention time 13.9 min.

EXAMPLE 6 : pGlu-His-Trp-Ser-Tyr-D-Leu-Npg-Arg-Pro-NEt

Assembling and cleavage of the peptide were carried out as described for Example 2.
Purification was carried out in two steps, the first one using a linear gradient of from 15 to 50 % of eluent B over 30 min., and the second one using a linear gradient of from 15 to 40 % of eluent B over 30 min.
49 mg (approximate yield 20 %) of purified material were obtained.

Mass spectral analysis - ES^+ mode :

expected : 1222.4
found : 1223.6 (MH^+)

net peptide content 73.6 % ; purity 95.3 % ; retention time 14.6 min.

EXAMPLE 7: pGlU-His-Trp-Ser-Tyr-D-Npg-Npg-Arg-Pro-Gly-NH_2

Assembling and cleavage of the peptide were carried out as described for Example 1.
Purification was carried out in two steps, the first one using a linear gradient of from 30 to 60 % of eluent B over 30 min., and the second one using a linear gradient of from 25 to 60 % of eluent B over 30 min.
13 mg (approximate yield 4%) of purified material were obtained.

Mass spectral analysis -ES^+ mode :

expected : 1265.5
found 1266.0

net peptide content 71.1 % ; purity 97.8% ; retention time 15.1 min.

EXAMPLE 8: pGlu-His-Trp-Ser-Tyr-D-Npg-Npg-Arg-Pro-NEt

Assembling and cleavage of the peptide were carried out as described for Example 2.
Purification was carried out using a linear gradient of from 20 to 80 % of eluent B over 30 min.
13 mg (approximate yield 4%) of purified material were obtained.

Mass spectral analysis - ES^+ mode :

expected : 1236.4
found : 1237.5 (MH^+)

net peptide content 68.5 % ; purity 96.2 % ; retention time 13.9 min.

EXAMPLE 9 : pGlu-His-Trp-Ser-Tyr-D-Phe-Npg-Arg-Pro-Gly-NH_2

The synthesis was carried out as described for example 1.
Purification was carried out using a linear gradient of from 25 to 80 % of eluent B over 30 min.
61 mg (approximate yield 16 %) of purified material were obtained.

Mass spectral analysis - ES^+ mode :

expected : 1285.5
found : 1286.2 (MH^+)

net peptide content 71.8 % ; purity 96.8 % ; retention time 14.9 min.

EXAMPLE 10 : pGlu-His-Trp-Ser-Tyr-D-Phe-Npg-Arg-Pro-NEt

Assembling and cleavage of the peptide were carried out as described for example 2.
Purification was carried out using a linear gradient of from 20 to 80 % of eluent B over 30 min.
6 mg (approximate yield 4 %) of purified material were obtained.

Mass spectral analysis - ES^+ mode :

expected : 1256.4
found : 1257.4 (MH^+)

net peptide content 63.2 % ; purity 96.9 % ; retention time 13.9 min.

EXAMPLE 11: pGlu-His-Trp-Ser-Tyr-D-Trp-Npg-Arg-Pro-Gly-NH_2

Assembling and cleavage of the peptide were carried out as described for example 1.
Purification was carried out using a linear grandient of from 20 to 80 % of eluent B over 30 min.
22 mg (approximate yield 7 %) of purified material were obtained.

Mass spectral analysis - ES^+ mode :

expected : 1324.5
found : 1325.5 (MH^+)

net peptide content 71.6% ; purity 97.1 % ; retention time 13.1 min.

EXAMPLE 12: pGlu-His-Trp-Ser-Tyr-D-Trp-Npg-Arg-Pro-NEt

Assembling and cleavage of the peptide were carried out as described for example 2.
Purification was carried out using a linear gradient of from 20 to 80 % of eluent B over 30 min.

10 mg (approximate yields 5 %) of purified material were obtained.

Mass spectral analysis - ES^+ mode :

expected : 1295.4
found : 1296.3 (MH^+)

net peptide content 71.3 % ; purity 98.4% ; retention time 13.8 min.

EXAMPLE 13: pGlu-His-Trp-Ser-Tyr-D-Nal-Npg-Arg-Pro-Gly-NH_2

Assembling and cleavage of the peptide were carried out as described for example 1.
Purification was carried out using a linear gradient of from 15 to 75 % of eluent B over 30 min.
205 mg (approximate yield 50 %) of purified material were obtained.

Mass spectral analysis - ES^+ mode :

expected : 1335.6
found : 1336.2 (MH^+)

net peptide content 74.8%; purity 95.6% ; retention time 14.9 min.

EXAMPLE 14: pGlu-His-Trp-Ser-Tyr-D-Nal-Npg-Arg-Pro-NEt

Assembling and cleavage were carried out as described for example 2.
Purification was carried out using a linear gradient of from 25 to 50 % of eluent B over 30 min.
82 mg (approximate yield 22 %) of purified material were obtained.

Mass spectral analysis - ES^+ mode :

expected : 1306.5
found : 1307.2 (MH^+)

net peptide content 76.0% ; purity 97.4% ; retention time 15.8 min.

EXAMPLE 15 : AcD-Nal-D-pClPhe-D-Pal-Ser-NicLys-D-NicLys-Npg-IprLys-Pro-D-Ala-NH_2

The synthesis was carried out on a 4-methylbenzhydrylamine resin.
D-alanine and proline were introduced using a Boc strategy as described above for the general synthesis of the invention peptides. The other amino acids were incorporated via a Fmoc strategy as described above.
The synthesis was started with Boc-D-Ala-OH.
The peptides were deprotected and cleaved from the resin using HF as described above.
Purification was carried out using a linear gradient of from 15 to 70 % of eluent B over 30 min.
49 mg (approximate yield 31 %) of purified material were obtained.

Mass spectral analysis - ES^+ mode :

expected : 1605.3
found : 1605.5

net peptide content 67.6% ; purity 98.3 % ; retention time 15.5 min.

EXAMPLE 16: AcD-Nal-D-pClPhe-D-Pal-Ser-Tyr-D-Cit-Npg-Arg-Pro-D-Ala-NH_2

Assembling and cleavage of the peptide were carried out as described for example 15, arginine being introduced using a Boc strategy.
Purification was carried out using a linear gradient of from 30 to 60 % of eluent B over 30 min.
16 mg (approximate yield 9 %) of purified material were obtained.

Mass spectral analysis - ES^+ mode :

expected : 1444.9
found : 1444.6

net peptide content 67.1 % ; purity 97.0% ; retention time 16.8 min.

EXAMPLE 17: AcD-Nal-D-pClPhe-D-Pal-Ser-Tyr-D-Cit-Npg-IprLys-Pro-D-Ala-NH_2

Assembling and cleavage of the peptide were carried out as described for Example 15.
Purification was carried out using a linear gradient of from 10 to 60 % of eluent B over 30 min.
55 mg (approximate yield 29 %) of purified material were obtained.

Mass spectral analysis - ES^+ mode :

expected value : 1459.9
found : 1459.3

net peptide content 69.8 % ; purity: 96.4% ; retention time 11.2 min.

EXAMPLE 18 : AcD-Nal-D-pClPhe-D-Pal-Ser-Tyr-D-HCit-Npg-IprLys-Pro-D-Ala-NH_2

Assembling and cleavage of the peptide were carried out as described for example 15.
Purification was carried out using a linear gradient of from 30 to 50 % of eluent B over 30 min.
40 mg (approximate yield 17%) of purified material were obtained.

Mass spectral analysis - ES^+ mode :

expected : 1473.2
found : 1473.2

net peptide content 69.8 % ; purity 95.7 % ; retention time 15.9 min.

EXAMPLE 19: AcD-Nal-D-pClPhe-D-Pal-Ser-Tyr-D-HCit-Npg-Arg-Pro-D-Ala-NH_2

Assembling and cleavage of the peptide were carried out described for example 16.
Purification was carried out using a linear gradient of from 30 to 60% of eluent B over 30 min.
55 mg (approximate yield 21 %) of purified material were obtained.

Mass spectral analysis - ES^+ mode :

expected : 1459.1
found : 1459.2

net peptide content 68.2% ; purity 96.6% ; retention time 15.7 min.

REFERENCES

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The Peptides, , Analysis, Synthesis, Biology, Vol. 2, Chapter 1.
(2) E. ATHERTON and R.C. SHEPPARD (1989)
Solid phase peptide synthesis, IRL Press, OXFORD
(3) D. Le NGUEN, A. HEITZ and B. CASTRO (1987)
J. Chem. Soc. Perkin Trans. I, 1915
(4) E. KAISER, R.L. COLESCOTT, C.D. BOSSINGER and P.I. COOK (1970)
Anal. Biochem., 34, 595
(5) P.N. RAO, J.E. BURDETT Jr, J.W. CESSAD, C.M. DI NUNNO, D.M. PETERSON and H.K. KIM (1987)
Int. J. Pept. Protein Res., 29, 118

SEQUENCE LISTING

(1) GENERAL INFORMATION:

(i) APPLICANT:
(A) NAME: Laboratoire Theramex
(B) STREET: 6, Avenue du Prince Hereditaire Albert
(C) CITY: Monaco
(E) COUNTRY: Monaco
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(ii) TITLE OF INVENTION: LH-RH peptide analogues, their uses and pharmaceutical compositions containing them.

(iii) NUMBER OF SEQUENCES: 5

(iv) COMPUTER READABLE FORM:
(A) MEDIUM TYPE: Floppy disk
(B) COMPUTER: IBM PC compatible
(C) OPERATING SYSTEM: PC-DOS/MS-DOS
(D) SOFTWARE: PatentIn Release #1.0, Version #1.30 (EPO)

(2) INFORMATION FOR SEQ ID NO: 1:

(i) SEQUENCE CHARACTERISTICS:
(A) LENGTH: 10 amino acids
(B) TYPE: amino acid
(D) TOPOLOGY: linear

(ii) MOLECULE TYPE: peptide

(ix) FEATURE:
(A) NAME/KEY: Modified-site
(B) LOCATION:1
(D) OTHER INFORMATION:/note= "Xaa is pGlu ; D-pGlu ; Sar ; AcSar ; Pro ; AcPro ;ForPro ; OH-Pro ; Ac-OH-Pro ; dehydro-Pro ; Ac-dehydro-Pro ; Ser ; D- Ser ; Ac-D-Ser ; Thr ;D-Thr ; Ac-D-Thr ; or an optionally acylated aromatic D-amino acid"

(ix) FEATURE:
(A) NAME/KEY: Modified-site
(B) LOCATION:2
(D) OTHER INFORMATION:/note= "Xaa is a direct bond ; His ; or an aromatic D-amino acid"

(ix) FEATURE:
(A) NAME/KEY: Modified-site
(B) LOCATION:3
(D) OTHER INFORMATION:/note= "Xaa is an aromatic L- or D-amino acid"

(ix) FEATURE:
(A) NAME/KEY: Modified-site
(B) LOCATION:4
(D) OTHER INFORMATION:/note= "Xaa is Ala, Ser, D-Ser, MeSer, Ser(OBut), Ser(OBzl) or Thr"

(ix) FEATURE:
(A) NAME/KEY: Modified-site
(B) LOCATION:5
(D) OTHER INFORMATION:/note= "Xaa is an aromatic L-amino acid or a basic L- or D-amino acid"

(ix) FEATURE:

(A) NAME/KEY: Modified-site
(B) LOCATION:6
(D) OTHER INFORMATION:/note= "Xaa is Gly ; D-Pro ; D-Ser ; D-Thr ; D-Cys ; D-Met; D-Pen ; D-(S-Me)Pen ; D-(S-Et)Pen ; D-Ser(OBut) ; D-Asp(OBut) ; D-Glu(OBut) ;D-Thr(OBut) ; D-Cys(OBut) ; D-Ser(OR1) where R1 is a sugar moiety ; an aza-amino acid;D-His which may be substituted on the imidazole ring by a (C1-C6)alkyl or by a (C2-C7)acylgroup ; an aliphatic D-amino acid with a (C1-C8)alkyl or a (C3-C6)cycloalkyl side chain ; anaromatic D-amino acid ; D-cyclohexadienyl-Gly ; D-perhydronaphthyl-Ala ;D-perhydrodiphenyl-Ala ; or a basic L- or D-amino acid"

(ix) FEATURE:
(A) NAME/KEY: Modified-site
(B) LOCATION:7
(D) OTHER INFORMATION:/note= " Xaa may be N-alpha-substituted by a (C1-C4)alkyl group which may be substituted by one or several fluorine atoms"

(ix) FEATURE:
(A) NAME/KEY: Modified-site
(B) LOCATION:8
(D) OTHER INFORMATION:/note= "Xaa is a basic L- or D-amino acid"

(ix) FEATURE:
(A) NAME/KEY: Modified-site
(B) LOCATION:10
(D) OTHER INFORMATION:/note= "Xaa is GlyNH2 ; D-AlaNH2 ; azaGlyNH2 ; or a
group -NHR2 where R2 is an optionally substituted (C1-C4)alkyl "

(xi) SEQUENCE DESCRIPTION: SEQ ID NO: 1:

Xaa Xaa Xaa Xaa Xaa Xaa Xaa Xaa Pro Xaa
1 5 10

(2) INFORMATION FOR SEQ ID NO: 2:

(i) SEQUENCE CHARACTERISTICS:
(A) LENGTH: 10 amino acids
(B) TYPE: amino acid
(D) TOPOLOGY: linear

(ii) MOLECULE TYPE: peptide

(ix) FEATURE:
(A) NAME/KEY: Modified-site
(B) LOCATION:1
(D) OTHER INFORMATION:/note= "Xaa is pGlu, Sar or AcSar"

(ix) FEATURE:
(A) NAME/KEY: Modified-site
(B) LOCATION:2
(D) OTHER INFORMATION:/note= "Xaa is His"

(ix) FEATURE:
(A) NAME/KEY: Modified-site
(B) LOCATION:3,4,6,7
(D) OTHER INFORMATION:/note= " Xaa may be N-alpha-substituted by a (C1-C4)alkyl group which may be substituted by one or several fluorine atoms"

(ix) FEATURE:
(A) NAME/KEY: Modified-site
(B) LOCATION:5
(D) OTHER INFORMATION:/note= "Xaa is an aromatic L-amino acid"

(ix) FEATURE:
(A) NAME/KEY: Modified-site

(B) LOCATION:8
(D) OTHER INFORMATION:/note= "Xaa is a basic L-amino acid"

(ix) FEATURE:
(A) NAME/KEY: Modified-site
(B) LOCATION:10
(D) OTHER INFORMATION:/note= "Xaa is GlyNH2, azaGlyNH2 or a group -NHR2 where R2 is as defined for SEQ ID NO:1"

(xi) SEQUENCE DESCRIPTION: SEQ ID NO: 2:

Xaa Xaa Xaa Xaa Xaa Xaa Xaa Xaa Pro Xaa
1 5 10

(2) INFORMATION FOR SEQ ID NO: 3:

(i) SEQUENCE CHARACTERISTICS:
(A) LENGTH: 10 amino acids
(B) TYPE: amino acid
(D) TOPOLOGY: linear

(ii) MOLECULE TYPE: peptide

(ix) FEATURE:
(A) NAME/KEY: Modified-site
(B) LOCATION:1,3,4,5,7,8
(D) OTHER INFORMATION:/note= " Xaa may be N-alpha-substituted by a (C1-C4)alkyl group which may be substituted by one or several fluorine atoms"

(ix) FEATURE:
(A) NAME/KEY: Modified-site
(B) LOCATION:2
(D) OTHER INFORMATION:/note= "Xaa is a direct bond or an aromatic D-amino acid"

(ix) FEATURE:
(A) NAME/KEY: Modified-site
(B) LOCATION:6
(D) OTHER INFORMATION:/note= "Xaa is Gly ; D-Pro ; D-Ser ; D-Thr ; D-Cys ; D-Met; D-Pen ; D-(S-Me)Pen ; D-(S-Et)Pen ; D-Ser(OBut) ; D-Asp(OBut) ; D-Glu(O-But) ;D-Thr(O-But) ; D-Cys(O-But) ; D-Ser(O-R1) where R1 is a sugar moiety ; an aliphaticD-amino acid with a (C1-C8)alkyl or a (C3-C6)cycloalkyl side chain ; an aromatic D-aminoacid ; D-cyclohexadienyl-Gly ; D-perhydronaphthyl-Ala ; D-perhydrodiphenyl-Ala ; or a basicL- or D-amino acid"

(ix) FEATURE:
(A) NAME/KEY: Modified-site
(B) LOCATION:10
(D) OTHER INFORMATION:/note= "Xaa is GlyNH2 or D-AlaNH2"

(xi) SEQUENCE DESCRIPTION: SEQ ID NO: 3:

Xaa Xaa Xaa Xaa Xaa Xaa Xaa Xaa Pro Xaa
1 5 10

(2) INFORMATION FOR SEQ ID NO: 4:

(i) SEQUENCE CHARACTERISTICS:
(A) LENGTH: 10 amino acids
(B) TYPE: amino acid
(D) TOPOLOGY: linear

(ii) MOLECULE TYPE: peptide

(ix) FEATURE:

(A) NAME/KEY: Modified-sites
(B) LOCATION:1
(D) OTHER INFORMATION:/note= "Xaa is pGlu"

(ix) FEATURE:
(A) NAME/KEY: Modified-site
(B) LOCATION: 6
(D) OTHER INFORMATION:/note= "Xaa is Gly ; an aliphatic D-amino acid with a
(C1-C8)alkyl side chain ; or an aromatic D-amino acid"

(ix) FEATURE:
(A) NAME/KEY: Modified-sites
(B) LOCATION:7
(D) OTHER INFORMATION:/note= " Xaa may be N-alpha-substituted by a
(C1-C4)alkyl group which may be substituted by one or several fluorine atoms"

(ix) FEATURE:
(A) NAME/KEY: Modified-site
(B) LOCATION:10
(D) OTHER INFORMATION:/note= "Xaa is GlyNH2 or a group -NHC2H5"

(xi) SEQUENCE DESCRIPTION: SEQ ID NO: 4:

Xaa His Trp Ser Tyr Xaa Xaa Arg Pro Xaa
1 5 10

(2) INFORMATION FOR SEQ ID NO: 5:

(i) SEQUENCE CHARACTERISTICS:
(A) LENGTH: 10 amino acids
(B) TYPE: amino acid
(D) TOPOLOGY: linear

(ii) MOLECULE TYPE: peptide

(ix) FEATURE:
(A) NAME/KEY: Modified-sites
(B) LOCATION:1
(D) OTHER INFORMATION:/note= "Xaa is Ac-D-Nal"

(ix) FEATURE:
(A) NAME/KEY: Modified-sites
(B) LOCATION:2
(D) OTHER INFORMATION:/note= "Xaa is D-pClPhe"

(ix) FEATURE:
(A) NAME/KEY: Modified-sites
(B) LOCATION:3
(D) OTHER INFORMATION:/note= "Xaa is D-Pal"

(ix) FEATURE:
(A) NAME/KEY: Modified-sites
(B) LOCATION:5,8
(D) OTHER INFORMATION:/note= "Xaa is as defined for SEQ ID NO:3"

(ix) FEATURE:
(A) NAME/KEY: Modified-site
(B) LOCATION:6
(D) OTHER INFORMATION:/note= "Xaa is Gly or a basic L- or D-amino acid"

(ix) FEATURE:
(A) NAME/KEY: Modified-sites
(B) LOCATION: 7
(D) OTHER INFORMATION:/note= " Xaa may be N-alpha-substituted by a

(C1-C4)alkyl group which may be substituted by one or several fluorine atoms"

(ix) FEATURE:
(A) NAME/KEY: Modified-site
(B) LOCATION:10
(D) OTHER INFORMATION:/note= "Xaa is D-AlaNH2"

(xi) SEQUENCE DESCRIPTION: SEQ ID NO: 5:

Xaa Xaa Xaa Ser Xaa Xaa Xaa Xaa Pro Xaa
1 5 10

Claims

1. A LH-RH peptide analogue, in which Npg^7 is substituted for Leu^7 ; and its pharmaceutically acceptable salts.

2. A peptide according to claim 1, of the formula (SEQ ID N°: 1):
A1-A2-A3-A4-A5-A6-Npg-A7-Pro-Z (I)
in which:

- A1 is pGlu ; D-pGlu ; Sar ; AcSar ; Pro ; AcPro ; ForPro ; OH-Pro ; Ac-OH-Pro ; dehydro-Pro ; Ac-dehydro-Pro ; Ser ; D-Ser ; Ac-D-Ser ; Thr ; D-Thr ; Ac-D-Thr ; or an aromatic D-amino acid which may be acylated;
- A2 is a direct bond ; His ; or an aromatic D-amino acid;
- A3 is an aromatic L- or D-amino acid;
- A4 is Ala, Ser, D-Ser, MeSer, Ser(OBu^t), Ser(OBzl) or Thr;
- A5 is an aromatic L-amino acid or a basic L- or D-amino acid;
- A6 is Gly ; D-Pro ; D-Ser ; D-Thr ; D-Cys ; D-Met ; D-Pen ; D-(S-Me)Pen ; D-(S-Et)Pen ; D-Ser(OBu^t) ; D-Asp(OBu^t) ; D-Glu(OBu^t) ; D-Thr(OBu^t) ; D-Cys(OBu^t) ; D-Ser(OR_1) where R_1 is a sugar moiety; an aza-amino acid; D-His which may be substituted on the imidazole ring by a (C_1-C_6)alkyl or by a (C_2-C_7)acyl group ; an aliphatic D-amino acid with a (C_1-C_8)alkyl or a (C_3-C_6)cycloalkyl side chain ; an aromatic D-amino acid ; D-cyclohexadienyl-Gly ; D-perhydronaphthyl-Ala ; D-perhydrodiphenyl-Ala ; or a basic L- or D-amino acid;
- Npg may be N-alpha-substituted by a (C_1-C_4)alkyl group which may be substituted by one or several fluorine atoms;
- A7 is a basic L- or D-amino acid;
- Z is $GlyNH_2$; D-$AlaNH_2$; $azaGlyNH_2$; or a group -NHR_2 where R_2 is a (C_1-C_4)alkyl which may be substituted by an hydroxy or one or several fluorine atoms, a (C_3-C_6)cycloalkyl or a heterocyclic radical selected from morpholinyl, pyrrolidinyl and piperidyl;
and its pharmaceutically acceptable salts.

3. A peptide according to claim 2, of the formula (SEQ ID N° : 2):
A1-A2-A3-A4-A5-A6-Npg-A7-Pro-Z (IIa)
in which:

- A1 is pGlu, Sar or AcSar;
- A2 is His;
- A3 and A4 are as defined for (I) in claim 2;
- A5 is an aromatic L-amino acid;
- A6 is Gly ; D-Pro ; D-Ser ; D-Thr ; D-Cys ; D-Met ; D-Pen ; D-(S-Me)Pen ; D-(S-Et)Pen ; D-Ser(OBu^t) ; D-Asp(OBu^t) ; D-Glu(OBu^t) ; D-Thr(OBu^t) ; D-Cys(OBu^t) ; D-Ser(OR_1) where R_1 is a sugar moiety; an aza-amino acid; D-His which may be substituted on the imidazole ring by a (C_1-C_6)alkyl or by a (C_2-C_7)acyl group ; an aliphatic D-amino acid with a (C_1-C_8)alkyl or a (C_3-C_6)cycloalkyl side chain ; an aromatic D-amino acid ; D-cyclohexadienyl-Gly ; D-perhydronaphthyl-Ala ; D-perhydrodiphenyl-Ala ; or a basic D-amino acid;
- Npg is as defined for (I) in claim 2;
- A7 is a basic L-amino acid;

- Z is $GlyNH_2$, $azaGlyNH_2$ or a group $-NHR_2$ where R_2 is as defined for (I) in claim 2; and its pharmaceutically acceptable salts.

4. A peptide according to claim 2, of the formula (SEQ ID N° : 3):

A1-A2-A3-A4-A5-A6-Npg-A7-Pro-Z (IIb)

in which:

- A1 as defined for (I) in claim 2;
- A2 is a direct bond or an aromatic D-amino acid;
- A3, A4 and A5 are as defined for (I) in claim 2;
- A6 is Gly; D-Pro; D-Ser ; D-Thr ; D-Cys ; D-Met; D-Pen; D-(S-Me)Pen ; D-(S-Et)Pen ; D-Ser(OBu^t) ; D-Asp(OBu^t) ; D-Glu($O\text{-}Bu^t$) ; D-Thr($O\text{-}Bu^t$) ; D-Cys($O\text{-}Bu^t$) ; D-Ser($O\text{-}R_1$) where R_1 is a sugar moiety ; a aliphatic D-amino acid with a (C_1-C_8)alkyl or a (C_3-C_6)cycloalkyl side chain ; an aromatic D-amino acid ; D-cyclohexadienyl-Gly ; D-perhydronaphthyl-Ala ; D-perhydrodiphenyl-Ala ; or a basic L- or D-amino acid;
- Npg and A7 are as defined for (I) in claim 2;
- Z is $GlyNH_2$ or $D\text{-}AlaNH_2$;

and its pharmaceutically acceptable salts.

5. A peptide according to claim 3, of the formula (SEQ ID N° : 4):

pGlu-His-Trp-Ser-Tyr-A6-Npg-Arg-Pro-Z (IIIa)

in which:

- A6 is Gly ; an aliphatic D-amino acid with a (C_1-C_8)alkyl side chain ; or an aromatic D-amino acid;
- Npg is optionally N-alpha-methylated;
- Z is $GlyNH_2$ or a group $-NHC_2H_5$;

and its pharmaceutically acceptable salts.

6. A peptide according to claim 4, of the formula (SEQ ID N° : 5):

Ac-D-Nal-D-pClPhe-D-Pal-Ser-A5-A6-Npg-A7-Pro-$D\text{-}AlaNH_2$ (IIIb)

in which:

- A5 is as defined for (IIb) in claim 4;
- A6 is Gly or a basic L- or D- amino acid;
- Npg is optionally N-alpha-methylated;
- A7 is as defined for (IIb) in claim 4;

and its pharmaceutically acceptable salts.

7. A pharmaceutical composition which contains a effective amount of a peptide according to any one of claims 1 to 6, or of a pharmaceutically acceptable salt thereof.

8. A pharmaceutical composition according to claim 7 for oral or parenteral administration.

9. Use of a peptide according to any one of claims 1 to 6 for the preparation of a medicament for the treatment of infertility, hypogonadic or hypergonadic states, wherein said peptide is used alone or in combination with a sex steroid or a gonadotrophin.

10. Use of a peptide according to any one of claims 1 to 6 for the preparation of a contraceptive agent, wherein said peptide is used alone or in combination with a sex steroid or a gonadrotrophin.

11. Use of a peptide according to any one of claims 1 to 6 for the preparation of a medicament for the treatment or prevention of prostate cancer or benign prostatic hypertrophy, wherein said peptide is used alone or in combination with an androgen action inhibitor, a 5α-reductase inhibitor or a $C_{17\text{-}20}$ lyase inhibitor.

12. Use of a peptide according to any one of claims 1 to 6 for the preparation of a medicament for the treatment or prevention of breast cancer, wherein said peptide is used alone or in combination with an antiestrogen, an aromatase inhibitor or a $C_{17\text{-}20}$ lyase inhibitor.

13. Use of a peptide according to any one of claims 1 to 6 for the preparation of a medicament for the treatment or pre-

vention of sex hormone-related benign or malignant tumors, wherein said peptide is used alone or in combination with a hormonal or antitumoral agent.

14. Use of a peptide according to any one of claims 1 to 6 for the preparation of a medicament for the treatment or prevention of sex hormone-independent but LH-RH sensitive benign or malignant tumors, wherein said peptide is used alone or in combination with an antitumoral agent.

15. Use of a peptide according to any one of claims 1 to 6 for the preparation of a medicament for the treatment or prevention of benign or malignant lymphoproliferative disorders, wherein said peptide is used alone or in combination with an immunomodulating agent or an immunosuppressive agent.

16. Use of a peptide of formula (IIa) or (IIIa) according to claim 3 or 5 for the preparation of a medicament having LH-RH agonist activity.

17. Use of a peptide of formula (IIb) or (IIIb) according to claim 4 or 6 for the preparation of a medicament having LH-RH antagonist activity.

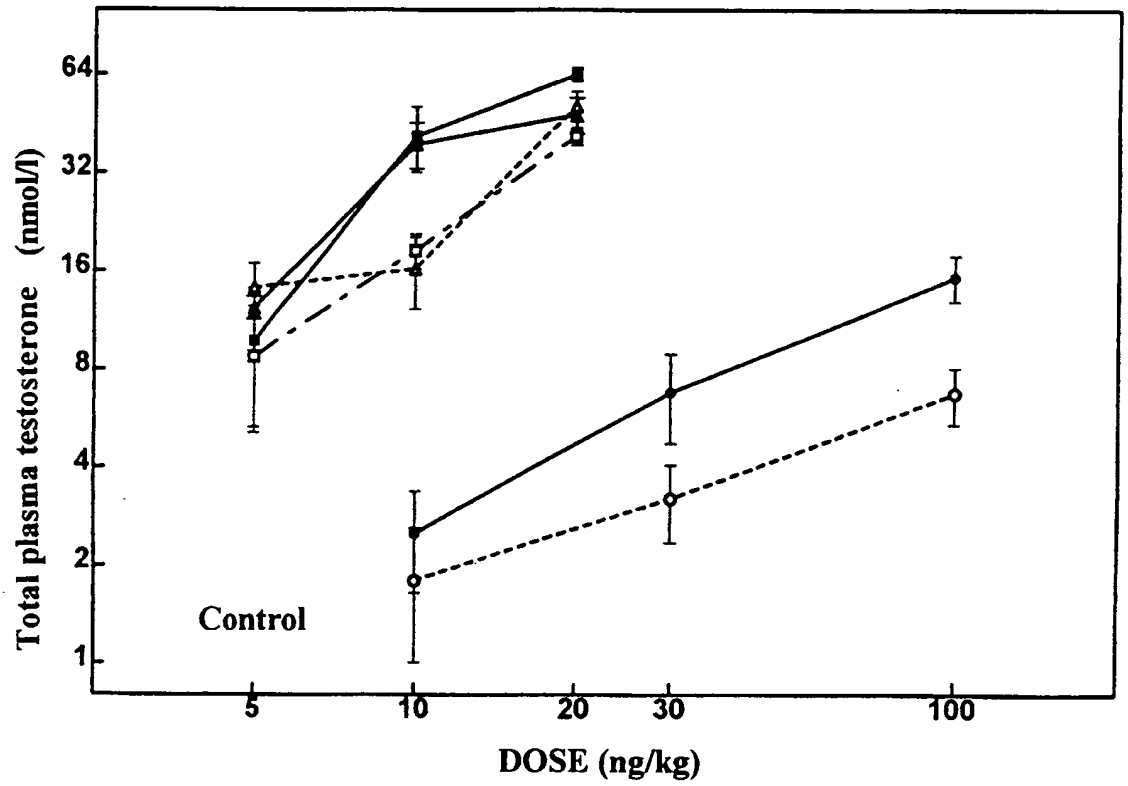
Total plasma testosterone (nmol/l)
64
32
16
8
4
2
1
Control
5
10
20
30
100
DOSE (ng/kg)
LH-RH
Example 1
Leuprorelin
Example 6
Tryptorelin
Example 11

FIG. 1

European Patent Office

EUROPEAN SEARCH REPORT

Application Number
EP 97 40 1212

DOCUMENTS CONSIDERED TO BE RELEVANT

Category	Citation of document with indication, where appropriate, of relevant passages	Relevant to claim	CLASSIFICATION OF THE APPLICATION (Int.Cl.6)
A	CHEMICAL ABSTRACTS, vol. 96, no. 1, 4 January 1982 Columbus, Ohio, US; abstract no. 7042, XP002038873 * abstract * & J.-L. FAUCHERE ET AL.: "Synthesis of gamma-methyl-L-leucine (neopentylglycine) and derivatives suitable for peptide synthesis" INTERNATIONAL JOURNAL OF PEPTIDE AND PROTEIN RESEARCH, vol. 18, no. 3, COPENHAGEN DK, pages 249-255, ---		C07K7/23
A	J. HLAVACEK ET AL.: "Synthesis and biological properties of cholecystokinin heptapetide analogues containing tert-leucine or neopentylglycine in position 5" COLLECTION OF CZECHOSLOVAK CHEMICAL COMMUNICATIONS, vol. 56, 1991, PRAGUE CS, pages 2209-2217, XP002038995 ---		TECHNICAL FIELDS SEARCHED (Int.Cl.6) C07K
A	M.J. KARTEN, J.E. RIVIER: "Gonadotropin-releasing hormone analog design." ENDOCRINE REVIEWS, vol. 7, no. 1, 1986, pages 44-66, XP002038872 * the whole document * -----		

The present search report has been drawn up for all claims

Place of search	Date of completion of the search	Examiner
THE HAGUE	20 October 1997	Cervigni, S

CATEGORY OF CITED DOCUMENTS

X : particularly relevant if taken alone
Y : particularly relevant if combined with another document of the same category
A : technological background
O : non-written disclosure
P : intermediate document

T : theory or principle underlying the invention
E : earlier patent document, but published on, or after the filing date
D : document cited in the application
L : document cited for other reasons

& : member of the same patent family, corresponding document

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